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AN ULTRASONIC METHOD OF PRODUCING CHIP BREAKERS

V. N. Verezub, et al.

The article relates an ultrasonic method of preparing chip breakers on the forward face of ceramic or hard-alloy blades of a cutting tool. By this means we can obtain chip breakers of any shape (recess, chamfer, hole) of a high class of surface cleanness (7th or 8th class) with complete lack of blade spoilage from burns, microcracks, or cavities.

Efficient breaking or curling of a chip may be done with chamfers, holes, and recesses of different shapes on the forward face of the instrument. Achieving the indicated type of chip breaker on blades of hard alloy or mineral ceramics is bound up with definite difficulties.

In the process of abrasive or electric-spark recess-grinding of chip breakers a great amount of heat is imparted to a relatively small area and thermal stresses are formed, the removal of material occurring under high unit pressures. This results in the appearance of microcracks, burns, and cavities in the grinding area; and the low cleanness of the machined surface is noticeable. In order to improve the quality of the surface layer of the processed material the application of cleaning and lapping operations is necessary, which extend the time for preparing the instrument and raise its cost.

Considerable difficulties occur in producing chip breakers on ceramic blades which are brittle by nature. Abrasive or electric-spark grinding of chip breakers cannot always ensure the necessary shape of the groove or hole.

It was necessary to find out a more precise method applicable under conditions prevailing in the grinding department of a machine shop because of the indicated defects in the existing methods.

In the Chelyabinsk tractor factory a more high-grade method* of forming a small hole has been developed with a cast-iron lapping disc and a paste of boron carbide. But this method is limited because of forming a hole of only one shape. In addition to that, when turning on lathes with fast feeds it is necessary when machining high alloy steels to make chip breakers of different shapes in order to provide efficient chip breaking.

The ultrasonic method is a universal means of obtaining chip breakers of the necessary shape.

The present work gives the results of research on this method in manufacturing chip breakers on ceramic and hard-alloy blades.

The apparatus made to carry out the experiments consisted of an UZG generator and a magnetostrictive head. The power of the generator's electrical oscillations was 600 w; frequency range, 16-30 kc; the operating frequency, 20 kc.

The generator schematic developed by us (Fig. 1) has a number of features. The driver is connected in the RC circuit of the generator, which permits us to change frequency smoothly in a broad range.

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* M. O. Nodel'man. An efficient chip-breaking method, Stanki i instrument, No. 4, 1959.

The voltage from the master oscillator is amplified by a 3-cascade amplifier and is passed on to the output power amplifier composed of four GK-71 tubes. The excitation and field coil of the oscillator are common.

The magnetostrictive head (Fig. 2) consists of a magnetostrictive converter, an exponential concentrator, and the working tool. The concentrator of 45 steel, on the free end of which there is a thread for the working tool, is fastened to one end of the magnetostrictive converter. The necessary static pressure of the working tool on the piece is provided by a selection of weights and varied within the limits of 500-800 g.

For precise measurement of the travel of the magnetostrictor and the working tool an indicator with a scale division of 0.01 was used.

In the region between the tool and the piece is introduced abrasive powder in water (an abrasive suspension). As abrasive we used boron carbide of 320, 220, 180, and 100 mesh and silicon carbide of 220, 180, and 100 mesh.

Blades of mineral ceramic TsM332 and hard alloy T15K6 were ultrasonically machined.

The shape of the grooves, holes, or recesses on the forward face of the tool may be radial, round, triangular, or rectangular depending on the material to be worked and the machining regime. Rather high requirements of precise manufacture and cleanness of the machined surface are made of the shape of these grooves.

Starting from the requirements for making chip breakers we set up research methods. The machining depth of the blades did not exceed one millimeter and the shape of the working tool corresponded to the

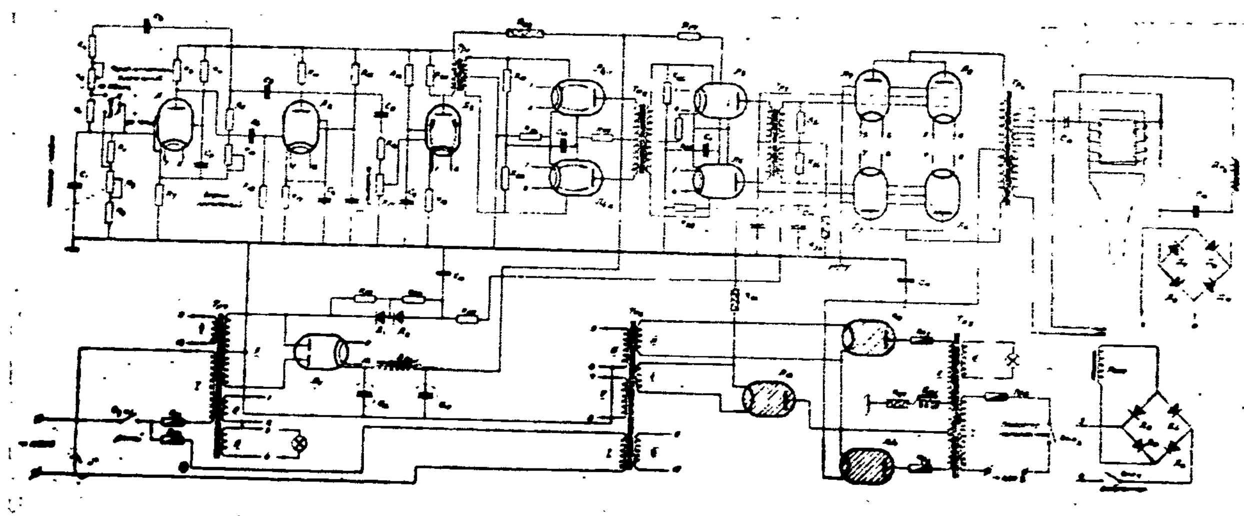

Fig. 1. Schematic of generator of ultrasonic oscillations.

contour to be machined. Figure 3 shows the shapes of the instruments adopted for the work. The tool of shape "a" may be used for making a chip-breaking recess; for making chamfers of the respective dimensions "b" and "c" tools were used; holes on the forward face may be made with "d" and "e" tools.

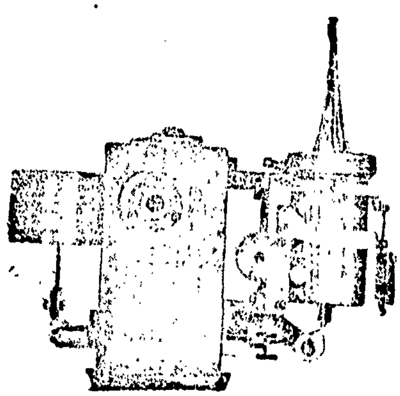

Fig. 2.

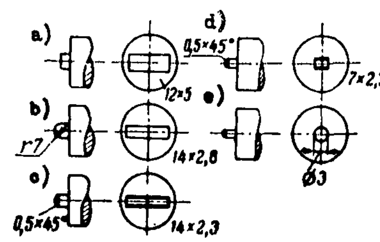

Fig. 3. Shapes of working tools.

The work investigated the effect of machining depth, tool area and shape, and also mesh and abrasive material on the manufacturing time of chip breakers on ceramic and hard alloy blades.

Figures 4 and 5 show the results of investigating the machining time of TsM332 and T15K6 as dependent on the depth, area, and shape of the tool.

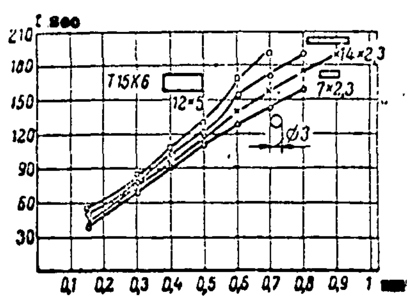

Fig. 4. Machining time dependence on tool depth for mineral ceramic TsM332.

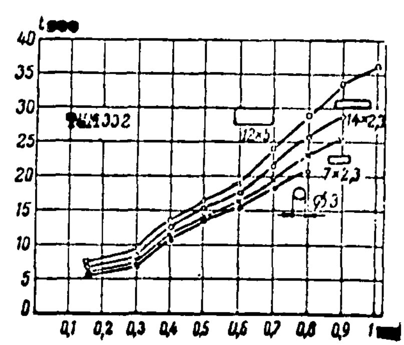

Fig. 5. Machining time dependence on tool depth for hard alloy T15K6.

Some of these curves shown in logarithmic coordinates more clearly illustrate the dependence of the time on the depth of the tool. As is evident from the figure, the rate in the increase of the time is slower than that of the depth and is defined by the exponent X = 0.8.

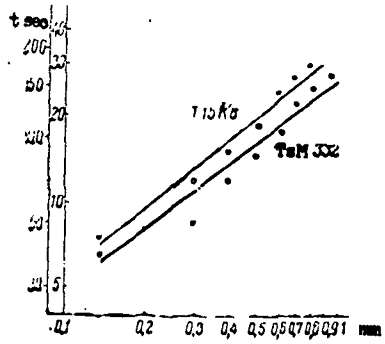

Fig. 6. Dependence of machining time on tool depth in logarithmic coordinates.

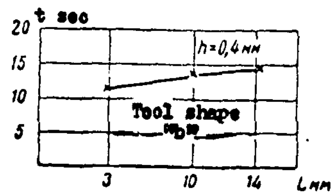

Fig. 7. Effect of length of working tool on machining time.

From an examination of the graphs (Figs. 4, 5) it is evident that at small depths up to 0.6 mm the machining time practically does not depend on the area of the working tool. For depths higher than 0.6 mm the area of the tool exerts an influence on the machining time: the smaller the area of the tool, the less the time needed for machining.

A change in the length of the tool has very little influence on the machining time for chamfers (Fig. 7).

At small tool depths the abrasive suspension freely enters the machining area and therefore production is a very insignificantly dependent on the area and shape of the tool adopted for investigation.

Comparison of the graphs in Figs. 3 and 4 shows that mineral ceramic works substantially faster than the hard alloy T15K6. For example, producing a 14 x 2.30 x 0.2 mm chamfer on a TsM332 blade takes 6-7 sec; but on T15K6, 50-60 sec.

As is evident from Fig. 8 the intensity of ultrasonic machining depends on the abrasive material and its mesh. Silicon carbide abrasive works 1.6-1.8 times slower than boron carbide.

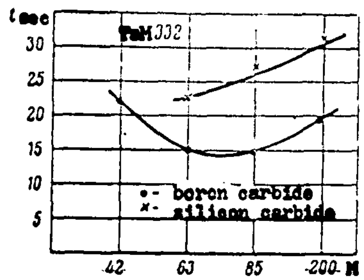

Fig. 8. Influence of abrasive mesh on machining time.

In ultrasonic machining an abrasive mesh must be chosen which fits the concentrator osicllation amplitude at which the machining time is at its minimum. In our experiments at an abrasive grain size of 63-85 μ and an oscillation amplitude of 25-30 μ the machining time was minimum.

The height of the microroughness H_{max} of the chip breaker surface for ultrasonically machined hard alloy and ceramic blades is within the limits of the 7th-8th class.

Removal of a layer of material in ultrasonic machining occurs at low temperature and unit pressures so that the surface layer has no defects at all (microcracks, burns). This is the great advantage of the ultrasonic method of producing chip breakers.

The productivity of the ultrasonic method of grinding mineral ceramic with boron carbide is 75-90 mm^3/min; and of hard alloy, 11-14 mm^3/min.

We may draw the following conclusions from the above:

1. The ultrasonic method of making chip breakers on ceramic and hard-alloy blades completely excludes spoilage from burns, microcracks, and cavities.

2. Any shape of chamfer, hole, or recess may be produced on the forward face.

3. Cleanness of the machined surface is within the limits of the 7th-8th class.

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